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Science Textbooks in the Context of Political Reform in South Africa: Implications for Access to Science

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ABSTRACT: The post-apartheid National Physical Science Curriculum was implemented for the first time in South Africa in grade 10 during 2006. A variety of new textbooks for grade 10 have been published. This study was a comparative analysis of three popular textbooks, one prepared to support the previous curriculum, and two prepared for the new curriculum. The study employed an eclectic theoretical approach and a mixed mode (qualitative and quantitative) methodology. The comparative analysis of the three textbooks showed that the old textbook presented pure, decontextualised physical science knowledge; presented conventional academic 'hard' science knowledge as strongly separated from the real world; and assumed that English was the first language of students. It emphasized factual and conceptual knowledge that students must remember and understand. It was underpinned by an objectivist epistemology and a rationalist philosophy of knowledge. One of the new textbooks was similar to the old. The other new textbook was inclusive, and presented science knowledge using a popular format and an interactive style. In addition to academic science knowledge, utilitarian knowledge was also presented. There was also an emphasis on factual and conceptual knowledge that students must remember and understand. The boundaries between science and the real world were weakened, and an obvious attempt to incorporate indigenous knowledge in the textbook was made. The new textbook seemed to be less mono-cultural, white, Eurocentric, and male-centered. Various language tools mediated English for second-language learners. In addition, it situated science knowledge in social, historical, and cultural experiences that students could identify with. Meta-cognitive reflection on the acquisition of academic and social competencies was consistently expected and there was also an expectation for higher cognitive processes, such as, analysis and evaluation. The textbook was underpinned by a social-constructivist epistemology and a humanistic philosophy of knowledge. The findings of this study support the conclusion that the new textbooks differ in terms of their potential to improve access to science for groups which have historically been marginalized.

Key words: Equity, knowledge representation, social representation, textbook analysis.

Introduction

South Africa (SA) is experiencing a transitional period of political transformation. Democracy replaced Apartheid in 1994, and, from then on, all sectors of society have experienced fundamental change, including education, schooling, and science curriculum. The post apartheid challenge of the new government has been

to broaden access to social resources for groups which have been marginalized through the policies of Apartheid. With political change in SA, radical curriculum change was advocated by national curriculum policy. Curriculum change has been motivated by a need for education to contribute to the social goals defined in the new Constitution. The aim of the school curriculum should not be to create functional literacy but critical literacy, powerful literacy, and political literacy that could enable power over and control of ones life (Apple, 2000). In the SA context, basic functional literacy had been denied to the vast majority during the Apartheid era. The new national curriculum is based on nine key principles, which are social transformation, outcomes-based education, high knowledge and high skills, integration and applied competence, progression, articulation and portability, human rights, inclusivity, environmental and social justice, valuing indigenous knowledge systems, and credibility, quality and efficiency.

New textbooks, in use for the first time in 2006, have been developed to create alignment between new curriculum policy and the textbooks used by teachers. Historically, textbooks have been important mediators of the curriculum experience of learners in South Africa. A recent newspaper article highlights popular perceptions of the central role that textbooks have played in South African education:

> *The textbook was, and still is in many cases, the syllabus, the body of knowledge that is to be remembered. For idle teachers, it is a crutch; for incompetents, who may also be idle, an excuse. It should be nothing more than a resource, and a basic one at that, one which sets out the framework of the syllabus. It should support the teacher, not replace him or her, nor become either the fount of knowledge or the catalyst of progress. But the attitude of many, in and out of the teaching profession, is to subvert beneath the textbook the role of the teacher* (Layman, A. The Witness, 12 January 2007).

This quote could be criticized for simplistically ascribing over reliance on textbooks to lazy or incompetent teachers, while ignoring the very real negative effects that previous education and teacher development policies and practices have had on teacher ability. However, it does highlight that textbooks and their use in South African education needs to be examined through research. Apple and Christian-Smith (1991) reinforced this position when they stated that "... *little attention has been paid to the one artifact that plays such a major role in defining whose culture is taught: the textbook*" (p. 1) They argued that while many studies have been conducted on textbooks, very few paid attention to the relations of inequality in the social context in which the studies have been conducted.

Existing textbook analysis from the critical perspective focuses on race, class, gender, and disability bias in textbooks. Sleeter and Grant (1991) analyzed how America's diversity was projected to children through the school day. They examined the question: '*how have the writers and publishers ...selected knowledge of various American racial, social class, gender, and disability groups?*' (p. 281). They concluded that treatment of diversity in textbooks has not improved much over the past fifteen years. They argued that the move in the 60s and 70s to 'multiculturalize' textbooks may have stopped and that there may be a return to White and male-dominated curricula. This, they argue, '*would be quite dangerous, producing citizens with a*

shallow social consciousness and narrow sense of history and culture, and alienating from school lower-class children and children of color' (p. 297). McKinney (2005) investigated to what extent textbooks are appropriate for diverse learners in SA and found inequity in gender representation, "*significant under-representation of rural, poor, disabled and working-class social worlds, though racial diversity was better represented*" (p. xi). Collada and Atxurra (2006) analyzed how textbooks deal with issues of education for democratic citizenship encompassed within the European framework and Spanish educational reforms. They found that the ideals of citizenship are dealt with unevenly, and in some cases barely, in these textbooks. Democratic co-existence, reflective and critical skills, diversity, and human rights were dealt with in a cursory, descriptive, or even superficial manner. They concluded that if preparation for co-existence is one of the objectives of the curriculum, then greater attention ought to be given to it in textbooks. From the perspective of developing a scale to assist in the selection of textbooks, Nworgu (2001), cited in Emereole (2007), developed a five point quantitative approach to evaluating the content of science textbooks. The five indices identified were: *topical coverage index* that provides an estimate of the extent to which the textbook covers the prescribed syllabus; *learning activity index* that measures participation of learners; *study questions index* that measures the extent to which learners are required to think or to receive knowledge; the *illustration index* that measures the extent to which learners are required to engage in an activity or to view/observe the illustration; and *the chapter summary index* that measures the extent to which a more permanent understanding of the text is promoted. Emereole (2006) added the under-represented population index for measuring the extent to which women, and cultural and ethnic diversity is represented in neutral or biased ways.

The present study investigated knowledge representation as well as representation of diversity in terms of race, class, gender, and language in textbooks prepared to support the new curriculum in South Africa. The following questions frame the study:

- How are the textbooks, prepared for the new curriculum, different from the old in relation to how they represent knowledge, process, and social relations?
- What are the implications of this for student access to physical science?

The study aimed to show if/how these representations have changed as a result of the political transition, and the resulting curriculum policy change, and in our concluding discussion, to consider what implications this may have for access, equity, and life chances of students.

Theoretical and Analytical Resources

Critical thinkers have argued that it is naïve to think of the school curriculum as neutral knowledge (Apple, 2000; Giroux, 1994; Fiske, 1989). Bernstein (1990) argued that the basic question to be asked with reference to the privileging pedagogic text is whether the text "*focus upon the pedagogic subject's relation to this text in terms of his/her social class, gender, race attributes, or any other discriminating attribute*", or whether the privileging text focuses upon its "*internal constituents in the process of*

transmission and acquisition..." (pp. 173–174). Bernstein (1996) clearly distinguished the social representation of the discipline from its epistemological worth. While the knowledge and procedures of the discipline (message) are embedded in its social representation (the medium), Bernstein (1996) highlighted that the focus in the text – the medium and/or the message - is of importance.

In highlighting the importance of textbooks, Apple (2000) suggested that textbooks, both through their form and their content, *represent* particular *selections* from a '*vast universe of possible knowledge*' and particular *constructions* of [social] reality, which can serve to empower particular groups, while disempowering others. Drawing from this view, the term '**representation**' is used in this paper to project both the *selection* and *construction* character of textbooks. The analysis focuses on the social representation of science (medium/form) as well as its epistemological representation (message/content).

Knowledge Representation in Science Textbooks

Bernstein's notion that curriculum texts in setting out what knowledge is to be taught recontextualize both the regulative discourses of the state as well as conventional instructional discourses was informative. Bernstein (1996) distinguished between the specific instructional discourse and the specific regulative discourse. Specific Instructional Discourse (SID) refers to knowledge and cognitive competences, which indicate the knowledge contents to be taught in the teaching-learning context. Specific Regulative Discourse (SRD) refers to values, attitudes, and socio-affective competences, which establish order relation and identity in the teaching-learning context.

To be able to analyze finer distinctions in the instructional discourse, Goodson's (1987) analysis of traditions that recur in the history of school subjects were drawn on. The high status *academic tradition* is content-focused and typically stresses abstract and theoretical knowledge for examination. The *utilitarian tradition* focuses on practical knowledge related to the non-professional vocations. Goodson (1987) noted that the utilitarian tradition is of low status as it deals with practical knowledge not amenable to written examination. In this analysis, utilitarian knowledge is considered to be knowledge presented in a contextualized fashion in relation to its use to humankind. Another kind of contextualization involved presenting knowledge in combination with examples that illustrated it.

Goodson's distinctions between the academic and utilitarian traditions do not capture the notion of indigenous knowledge, a form of knowledge emphasized in the new curriculum for South African schools. The National Curriculum Statement for Physical Sciences (Department of Education, 2003) suggested that one of the purposes in studying Physical Science is to *develop insights and respect for different scientific perspectives and a sensitivity to cultural beliefs; prejudices and practices in society' emphasizing that 'this aspect should also include the mobilizing of African indigenous scientific knowledge and practices, particularly as these relate to solving social and environmental challenges in Africa*' (p. 9). Several writers (Aikenhead, 1997; Jegede, 1997; Nines, 2001) have pointed to the possibility of various *'ways of knowing'* – academic or canonical (western) science being only one of these. These writers have suggested that indigenous communities are able to understand and explain the world

(including the scientific world) using unique and locally generated forms of knowledge. Aikenhead (1997) has described Native Americans ways of knowing to include shared experiences, perceptions, thoughts, memories, dreams, visions, and signs. He further argued that traditional science education has ignored or devalued these ways of knowing, in the process reinforcing and maintaining the dominant status of western (canonical) science. Ninnes (2000) suggested that this is a form of '*ethnocentricism, racism or cultural imperialism which needs to be countered with a more balanced approach.*' Following from this, a multicultural science education that would be more affirming of the experience and possibilities that local communities have to offer, and that involves working with diverse forms of knowledge, could create better access to science for learners from different backgrounds.

To be able to analyze finer distinctions in knowledge and cognitive processes expected, Bloom's revised taxonomy was drawn on. According to the revised taxonomy the main levels in the knowledge dimension are:

- ***A.*** *Factual knowledge* – The basic elements that learners must know to be acquainted with a discipline or solve problems in it.
- ***B.*** *Conceptual knowledge* – The interrelationships among the basic elements within a larger structure that enable them to function together.
- ***C.*** *Procedural knowledge* – How to do something, methods of enquiry, and criteria for using skills, algorithms, techniques, and methods.
- ***D.*** *Metacognitive knowledge* – Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.

The main levels in the cognitive process dimension are:

- ***1.0*** *Remember* – Retrieving relevant knowledge from long-term memory
- ***2.0*** *Understand* – Determining the meaning of instructional messages, including oral, written, and graphic communication.
- ***3.0*** *Apply* – Carrying out or using a procedure in a give situation.
- ***4.0*** *Analyze* – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.
- ***5.0*** *Evaluate* – making judgments based on criteria and standards.
- ***6.0*** *Create* – Putting elements together to form a novel, coherent whole or making an original product.

(Krathwohl, 2002, pp. 214, 215).

Social Representations in Science Textbooks

Apple (1988) argued that it is the textbook that often defines what counts as the elite and legitimate culture to pass on. Texts are not neutral. They are contested social artifacts. *They are at once the results of political, economic and cultural activities, battles and compromises. They are conceived, designed, and authored by real people with real interests. They are published within the political and economic constraints of markets, resources and power*' (Apple, 2000, p. xx). As a result, textbooks have been shown to have class, gender, and race bias. "*All too often', 'legitimate knowledge' does not include the historical experiences and cultural expressions of labor, women, people of color, and others who have been less powerful*" (Apple, 2000, p. xx)

Sleeter and Grant (1991) suggested that textbooks are *symbolic representations* of the world and society that relate to power. First, they confer legitimacy on the dominant status of particular social groups. Second, they render socially constructed relations as natural. Third, the curriculum screens in and out certain ideas and realms of knowledge that predisposes students to think and act in certain ways, and not to consider alternatives.

Apple (2000) wrote about the dual nature of power and suggested that texts have the power to regulate or liberate. To what extent do science texts project particular worldviews and particular identities as being legitimate, and so attempt to promote conformity and the reinforcement of these? Or is there an attempt at liberation through the recognition of diversity? These are questions with which this analysis is concerned.

Figure 1 provides an overview of this theoretical and analytical framework.

Methodology

Three grade 10 physical science textbooks were selected for analysis. Common content sections were analyzed across the three books and 20% of the content of each textbook was analyzed. The three textbooks were Senior Physical Science 8 (1985) hereafter referred to as Text A; Study & Master Physical Sciences Grade 10 (2005), hereafter referred to as Text B1, and Shuters Physical Sciences Grade 10 (2005), hereafter referred to as Text B2. Text A was one of two similar texts used widely by schools when the old curriculum was in place. A wide variety of textbooks (by at least 10 different publishers) have been produced to support the new curriculum. Texts B1 and B2 were chosen on the basis of widespread current usage by schools in the province in which the research was conducted.

The texts were divided into segments which were visual or verbal in nature. Visual segments took the form of diagrams, pictures, graphs, etc. Verbal segments were sentences or groups of sentences, which imparted a particular meaning. These segments formed the unit of analysis, and a mixed mode quantitative-qualitative methodology was used - qualitative in the sense that the researchers allocated meaning and interpretations to visual and verbal segments in the texts, and quantitative in the sense that the coded segments were added and subjected to basic statistical analysis. All segments that reflected knowledge dimensions were coded, as well as all segments that represented social dimensions. Segments that did not reflect knowledge contents, or social messages, for example, headings and lead-in statements, statements describing the structure of the curriculum and how it works, how it should be used by the teacher, and direct information to the teacher about how teaching should be conducted, or particular management or organizational-type instructions to the learner, were not coded.

Inter-coder reliability was established by the two researchers jointly deciding on what constituted the codable segments. The researchers then worked individually to assign individual codes to these sections of the documents. In follow-up meetings, coding discrepancies were discussed, defended, and consensually resolved. Figure 2 shows two pages from one of the textbooks. It shows how the text was divided into coded segments. Segments with a line through were left uncoded

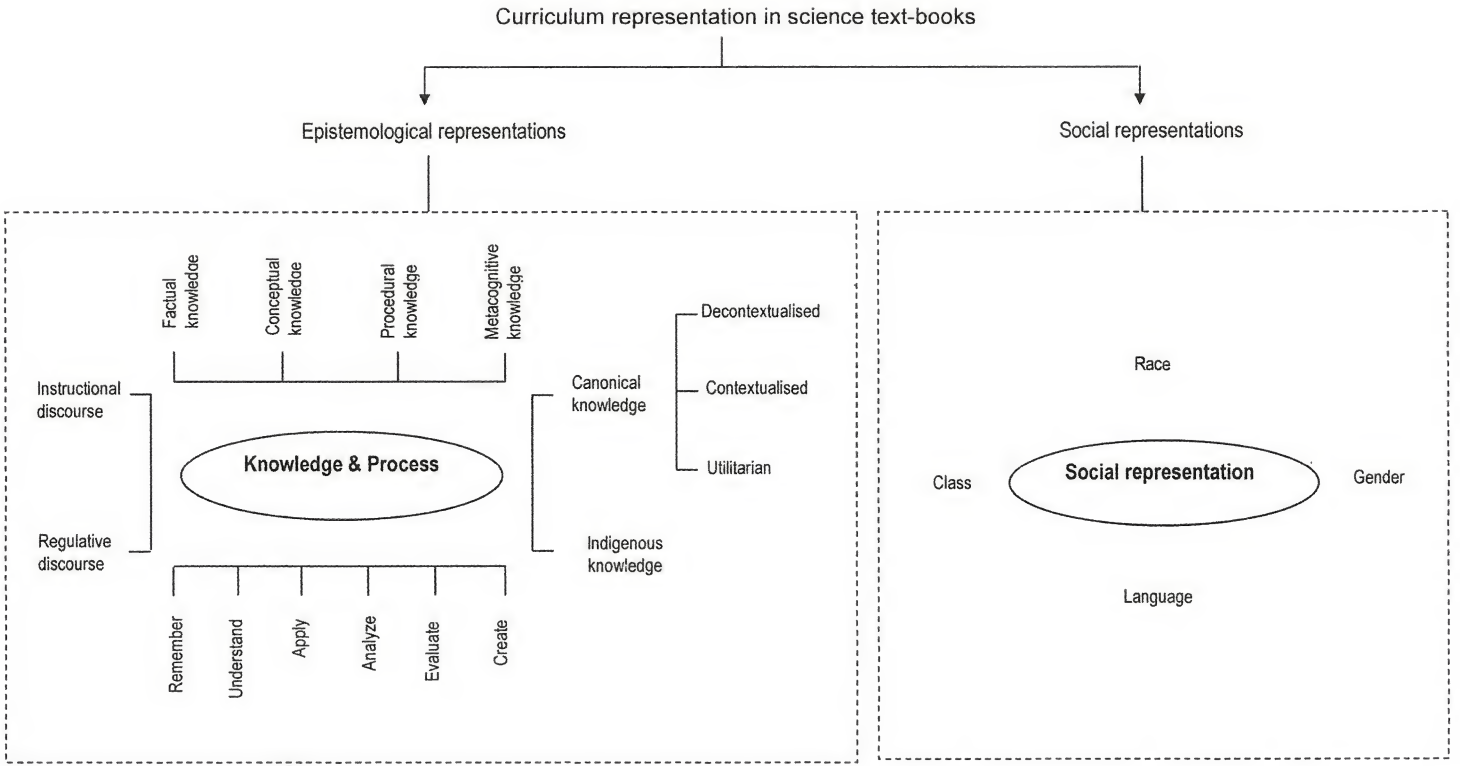

Figure 1. Epistemological and Social Representations: Describing the 'Message' and the 'Medium' in School Science Texts

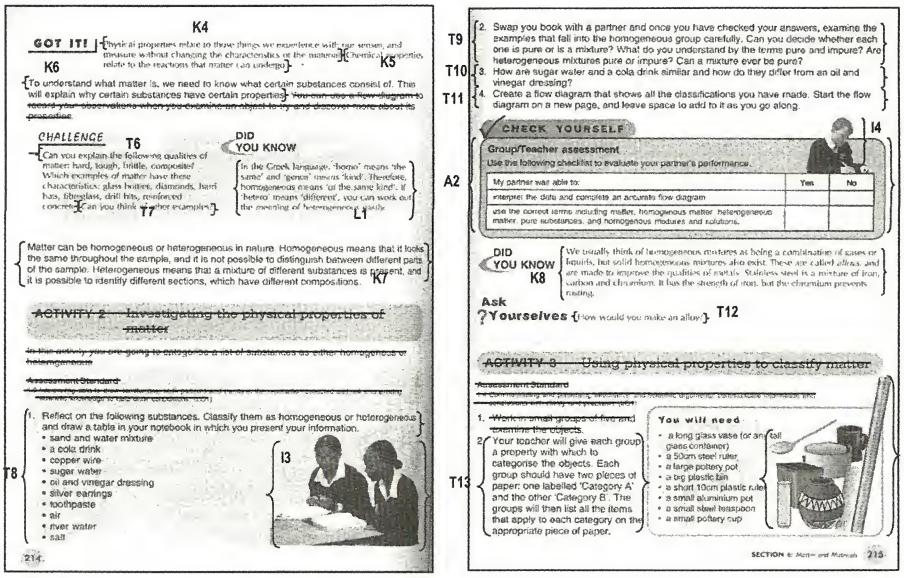

Figure 2. A Section of Text Divided into Coded Segments for Analysis

Analysis of Knowledge, Task, and Assessment Statements

K4, K5, K6, etc represented statements which conveyed knowledge. Each knowledge statement was analyzed using the following scheme:

- Which discourse is portrayed, i.e., the Regulative Discourse (RD) or the Instructional Discourse (ID) (Bernstein, 1996)?
- Which knowledge tradition is evident in the statement, i.e., an academic (canonical science) view or an indigenous science view?
- If academic knowledge was evident, was it being conveyed in a decontextualised, contextualized, or utilitarian fashion (Goodson, 1987)? A statement was classified as contextualized when an example was used to illustrate the statement, or when the statement was referenced to learners' everyday experiences. It was classified as utilitarian when reference was made to how the knowledge could be used.
- What kind of knowledge characterized the statement? Here a distinction was made between factual knowledge, conceptual knowledge, procedural knowledge, and metacognitive knowledge (Krathwohl, 2002).

As an example, statement K4 (see Figure 2) is a knowledge statement. It was coded as being part of the *instructional discourse*, reflected the *academic tradition*, was *conceptual* in nature, and was presented in a decontextualized fashion.

T6, T7, T8, etc represented statements, which required learners to perform particular tasks. A2 is an example of statements which involved assessment. Task

statements and assessment statements were analyzed using the same method described for the knowledge statements. In addition, for the task and assessment statements, the following question was also asked:

What process were learners expected to engage in through doing the activity? Processes included remember, understand, apply, analyze, evaluate, and create (Krathwohl, 2002). As an example, T8 (see Figure 2) is a task statement. It was coded as being part of the *instructional discourse*, reflected the *academic tradition*, was *conceptual* in nature, was presented in a contextualized fashion, and required that learners demonstrate *understanding* in order to respond effectively to it.

Analysis of Images

I3, I4, I5, etc represented images to be coded. For the images, the analysis determined whether they (a) portrayed academic or indigenous science in a decontextualized, contextualized, or utilitarian fashion (Goodson, 1987), (b) were images of a socio-scientific nature, or (c) were purely social images. For the socio-scientific and social images, the analysis further identified how they represented (a) race (African, colored, Indian, white[1]), and (b) gender (male or female).

As an example, I3 (see Figure 2) is a *socio-scientific* image, because it shows two *African, female*, science learners engaged in discussion, while referring to science texts.

Analysis of Language Statements

L1 is an example of a segment that attempted to make language more accessible. These segments were analyzed in the following way:

- Translation of an isiZulu[2] word in English.
- Translation of a foreign word/term into English or reference to the foreign roots of a word in order to make it clearer.
- Translation of an English word into isiZulu.
- Explanation of an English word in simpler English.

As an example, I3 is a language segment where reference is made to the foreign roots of a word in order to enhance understanding.

Analysis of Social Imagery in Verbal Statements

In addition to the categories described above, verbal statements in the texts were also scrutinized for any social images they conveyed. This analysis was conducted in a qualitative fashion and is reported on by description in the findings and discussion that follows. The methodological approach adopted was in one sense atomistic in that it reduced analysis of complex texts to a segment-by-segment

1. These categories represent how people were classified during the Apartheid dispensation. They are still widely used today when it is necessary to distinguish between groups of people.
2. isiZulu is the indigenous language (mother-tongue) spoken by a large proportion of the population in KwaZulu-Natal, a province in South Africa in which this research was conducted.

analysis, but in another sense holistic, in that it sought to interpret segments within the broader meanings in the text. The general trends uncovered through the detailed analysis seem to resonate with intuitive understanding gained through a more holistic engagement with the texts.

Findings

Knowledge Representations

Table 1 shows the number of knowledge statements in each textbook.

Table 1
Number Of Knowledge Segments Coded in Each Textbook

	Text A	Text B1	Text B2
Total number of knowledge statements coded	176 (100%)	238 (100%)	156 (100%)

Text B1 had the highest number of knowledge statements, followed by Text A, and then Text B2.

Discourses Emphasized in the Three Extracts

Table 2 shows the results in terms of the kind of discourse that was emphasized in each of the three textbooks.

Table 2
Regulative and Instructional Discourse in the Three Textbooks.

Discourse emphasis	Text A	Text B1	Text B2
% of segments reflecting the regulative discourse	0	0	10 (6.4%)
% of segments reflecting the instructional discourse	176 (100%)	238 (100%)	146 (93.6%)

Text A and B1 represented the instructional discourse only. Text B2 represented the regulative discourse in addition to the instructional discourse.

Ideological Traditions Reflected in the Three Textbooks

Table 3 presents the ideological traditions that were reflected in the three textbooks.

Table 3
Canonical and Indigenous Science in the Three Textbooks

Ideological tradition	Text A	Text B1	Text B2
% of statements reflecting academic knowledge represented in a decontextualised fashion	111 (63%)	126 (53%)	77 (49.6%)
% of statements reflecting academic knowledge represented in a contextualized fashion	65 (37%)	57 (24%)	57 (36.4%)
% of statements reflecting academic knowledge represented in a utilitarian fashion	0	55 (23%)	13 (8%)
% of statements reflecting indigenous knowledge	0	0	9 (6%)

In text A, academic science knowledge was represented as decontextualized and contextualized. Indigenous and utilitarian science knowledge was absent. In text B1, science knowledge was represented as decontextualized, contextualized, and utilitarian, but indigenous knowledge was absent. In text B2, science knowledge was represented as decontextualised, contextualized, and utilitarian. Knowledge which had been characterized as indigenous knowledge in the context of South Africa was represented in Text B2.

The obvious difference shown here was the presence of a significant increase in knowledge reflecting the utilitarian tradition in the new texts (B1 and B2). In combination, contextualized and utilitarian knowledge statements form a greater percentage in the new texts (B1 and B2) than in the old text (A).

Kinds of Knowledge Represented

In Table 4, the kind of knowledge that was represented in each textbook is shown.

Table 4
Kinds of Knowledge in the Three Textbooks

Kind of Knowledge	Text A	Text B1	Text B2
Factual	123 (70%)	195 (82%)	94 (60%)
Conceptual	42 (24%)	41 (17%)	51 (33%)
Procedural	11 (6%)	2 (1%)	2 (1%)
Metacognitive	0	0	9 (6%)

Text A and B1 emphasized factual and conceptual knowledge, while text A represented procedural knowledge most. Metacogntive knowledge was represented in Text B2 only as it incorporated the use of self-evaluation exercises, where learners were required to evaluate their own understanding and development.

Cognitive Processes Expected

The expected cognitive processes, as these have been identified in the three textbooks are shown in Table 5.

Table 5
Cognitive Processes Required in Activities in the Three Texts

Kinds of Process	Text A		Text B1		Text B2	
	Number	%	Number	%	Number	%
Remember	30	49.2	1	9.1	17	27
Understand	24	39.3	7	63.6	34	53.4
Apply	6	9.8	3	27.3	2	3.2
Analyze	1	1.7	0	0	1	1.6
Evaluate	0	0	0	0	9	14.3
Create	0	0	0	0	0	0
Total number of activities in each text	61	100	11	100	63	100

The analysis showed that: (a) There were significantly fewer activities in Text B1. (b) The majority of the activities in Text A required learners to 'remember,' while the majority of activities in Text B2 required learners to 'understand'. (c) Higher cognitive processes were expected in text B2 than in the other texts. It was the only text which expected learners to 'evaluate'. (d) In all three texts, learners were not expected to create science knowledge.

Social Representations

Table 6 shows the results of pictorial representations in the Three South African Science textbooks.

Table 6

Pictorial Representations (Scientific Pictures, Socio-scientific Pictures and Social Pictures) in Three South African Science textbooks

	Picture conveying academic (western) science in a... fashion			Picture conveying indigenous science in a... fashion			Socio-scientific picture	Social picture
	decontex.	context.	utilitar.	decontex.	context.	utilitar.		
Text A	8	1	0	0	0	0	0	0
Text B1	10	3	21	0	0	0	0	0
Text B2	3	2	2	0	1	0	17	2

In Text A, there were nine pictures. All of them were scientific diagrams reflecting the instructional discourse and projecting an academic view of science. Thirty-four images were analyzed in Text B1. All of them conveyed an academic view of science, with ten presenting science in a decontextualised fashion, three presenting a contextualized view of science, and twenty one showing scientific applications.

In Text B2, 27 images were examined. Of these: (a) Three represented a decontextualised, academic view of science, two a contextualized academic view of science, and two a utilitarian, academic view of science. These pictures served to illustrate ideas discussed in the text. (b) One picture represented an indigenous, utilitarian view, illustrating an application of indigenous knowledge. (c) The largest number of pictures (seventeen in all) represented a socio-scientific view, all showing learners engaged in various science learning activities like writing, reading, discussing, and carrying out an experiment. None of these pictures served to illustrate concepts in the text. (d) Two pictures were purely social in nature, showing a smiling face of a girl. Of all the pictures, artifacts within twenty-two of them were of a general nature. Two pictures contained artifacts which were indigenous / ethnic in nature.

Table 7 presents information relating to representations of gender and race in the pictures of the three textbooks.

Table 7
Representations of Race and Gender in the Socio-scientific Pictures and Social Pictures in Three South African Science Textbooks

	Socio-scientific picture	Social picture		Representation of race in the picture				Representation of gender in the picture	
	decontex.			African	coloured	Indian	white	male	female
Text A	8	0	0	0	0	0	0	0	0
Text B1	10	0	0	0	0	0	0	0	0
Text B2	3	17	2	8	3	4	4	8	11

All the socio-scientific and social pictures were in Text B2:

- Seven of them represented pair/group settings. All of them showed mono-racial groups (all African or all Indian learners in the group) except for the teacher-learner picture which showed a white teacher and a black learner.
- In terms of race, eight black learners were portrayed, three colored learners, four white learners and four Indian learners.
- In terms of gender, ten males and ten females were portrayed.
- Using the context and setting of the pictures as a guide, it was difficult to classify the class settings with confidence.

Comparison of Language Representations in the Textbooks

Table 8 presents information relating to comparison of language representations in the textbooks

Table 8
Language Representations in Three South African Science Textbooks

	Translation of an isiZulu word in English	Translation of a foreign word/term into English	Translation of an English word into isiZulu	Explanation of an English word in simpler English
Text A	No attention paid to language issues			
Text B1	No attention paid to language issues			
Text B2	8	5	0	1

Text B2 shows considerations of language support for second language learners, while Text A and Text B1 do not display any considerations of this. In Text B2, language mediation took the form of:

- Explaining foreign words or terms in English (eight instances of this in the sample analyzed).
- Explaining English words in simpler English (five instances of this in the sample analyzed).

- Explaining isiZulu words in English (one instance of this in the sample analyzed).

In this regard, it is interesting to note that in a region where the majority of learners have isiZulu as the mother tongue, there were no attempts to mediate this language in the textbook.

Social Imagery in Verbal Statements

Text B2 attempted to personalize science though the use of learner names in the text. In the extract below, the use of names seem to indicate collaboration in learning between two learners who had different cultural backgrounds, one western and the other Zulu.

> *'Sipho and Peter are examining the label on a bottle of honey. The label says 'pure honey.' Sipho says the label means it's natural honey, with nothing else added, whereas Peter says that it isn't really pure, but a mixture of a lot of different substances. Who is right?'* (Grussendorf et al., 2005, p. 217)

Text B2 also provided some indication of the people behind the science. It attempted to humanize science by providing background information about people who contributed to knowledge development in the area. For example:

> *As long ago as 400 B.C. Hippocrates of Greece recommended a tea made from the leaves of the willow tree to fight fever and pain. Now we know that the active ingredient is salicylic acid. Aspirin is also salicylic acid – manufactured- so that we no longer need to use leaves. Is salicylic acid an indigenous remedy or not?'* (Grussendorf et al., 2005, p. 219)

> *Other elements are even named after famous scientists. Nobelium was named after Alfred Nobel. The Nobel Prize which is awarded to people voted to be the best in certain fields was named after him' (Grussendorf et al., 2005,* p. *223).*

These techniques were absent in Text A and Text B1.

Discussion

In summary, text A represented the instructional discourse only; it privileged pure, socially decontextualised physical science knowledge; presented conventional academic 'hard' science knowledge as strongly separated from the real world; and assumed English as the first language of students. It emphasized factual and conceptual knowledge that students must remember and understand. It appeared to be underpinned by an objectivist epistemology and a rationalist philosophy of knowledge. Text B1 was similar in most respects to the old text A, with one striking difference – a much larger focus on the utilitarian value of science knowledge.

In contrast, the second new textbook B2 attempted to be much more inclusive, and has softened science by the use of a popular format and an interactive style. In addition to academic science knowledge utilitarian knowledge was referenced. There was an emphasis on factual and conceptual knowledge that students must remember and understand. The boundary between science and the real world has been weakened. An attempt has been made to include indigenous knowledge. The second new textbook was less mono-cultural, white, Eurocentric, and male-centered. Various language tools mediated the English language. In addition it situat-

ed science knowledge in social, historical, and cultural experiences that students could identify with. Also, meta-cognitive reflection on the acquisition of academic and social competences was consistently expected and there was an expectation for higher cognitive processes like analysis and evaluation. It appeared to be underpinned by a social-constructivist epistemology and a humanistic philosophy of knowledge.

A previous paper by the authors (Green & Naidoo, 2006) showed how knowledge representation has changed in the current curriculum reform process. An analysis of post-Apartheid curriculum documents showed that the new curriculum, introduced into South African schools in 2006, was significantly different from its apartheid-era predecessor in the type of knowledge it advocated. It was concluded that:

> *The NCS (National Curriculum Statement) reconceptualizes valid science knowledge. It explicitly endorses a fallibilist philosophy. Ideologically there is a shift from a purely academic ideology to a hybrid ideology that values the academic, utilitarian and social-reconstructionist purpose of science. Change is expressed in the regulative dimension of learning as well as in the instructional dimension of learning. The NCS is rich in symbols legitimating the state. The regulative dimension of learning is more highly valued in the NCS. The NCS is based on a range of competences, from the metacognitive level through to the simple level. In this sense, the NCS appears to be a much more comprehensive and complex document.* (Green & Naidoo, 2006, p. 71)

From this brief analysis of two of the new textbooks, it appears that writers and publishers have interpreted the requirements of the curriculum in different ways. Text B1 shows more congruence with the old-style textbook and with the epistemological and social flavor of the previous curriculum. Findings in relation to Text B2 indicate a greater alignment with the requirements of the new curriculum. Text B2 has attempted to broaden access to science through its user-friendly layout, its mediation of language, its inclusion of indigenous science, and its use of social imagery which is more embracing of the diversity that exists in South Africa. Text B1 has stuck much more closely to a traditional representation of science. Text B2 has attempted to broaden access to science.

In conclusion, and picking up on Bernstein's (1996) reference to the message and the medium of pedagogic texts, it is clear that when the new texts are compared to the old, for text B1, there has been some change in epistemological representation (the 'message' of the text), mostly in relation to a bigger focus on utilitarian science. However, this text shows no movement in relation to the social context in which science is embedded. Like the old text, it attempts to present science as a neutral, value-free, and dehumanized domain. Text B2 has shown significant change in relation to the epistemological dimension. It makes attempts to incorporate different ways of knowing, and pays attention to the social context of science learning. There are significant differences between the two texts, yet both are approved by the department of education as being representative of the new curriculum, and so as being representative of the new ideas about knowledge as well as social goals defined for the country.

References

AIKENHEAD, G. S. (1997). Towards a first nations cross-cultural science and technology curriculum. *Science Education, 81*(2), 217–238.

APPLE, M. W. (1998). *Teachers and texts: A political economy of class and gender relations in education.* London: Routledge.

APPLE, M. W. (2000). *Official knowledge.* London: Routledge.

APPLE, M. W., & Christian-Smith, l. (1991). *The politics of the textbook.* New York: Routledge.

BERNSTEIN, B. (1990). *Class, codes and control: Vol. IV, The structuring of pedagogic discourse.* London: Routledge.

BERNSTEIN, B. (1996). *Pedagogy, symbolic control and identity: Theory, research, critique.* London: Taylor and Francis.

COLLADO, M., & ATXURRA, R. (2006). Democratic citizenship in textbooks in Spanish primary curriculum. *Journal of Curriculum Studies, 38*(2), 205–228.

Department of Education. (2003). *National curriculum statement for grades 10–12 (general). Physical Sciences.* Pretoria: Government Printer.

EMEREOLE, H. U. (2007). *Comprehensive content evaluation of science textbooks: An 8-point model.* Paper presented at the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE), Maputo, Mozambique.

FISKE, J. (1989). *Reading the popular.* Boston: Unwin Hyman.

GREEN, W., & NAIDOO, D. (2006). Knowledge contents reflected in post-Apartheid South African Physical Science curriculum documents. *African Journal of Research in SMT Education, 10*(1), 71–80.

GIROUX, H. (1994). Teachers, public life and curriculum reform. *Peabody Journal of Education, 69*(3), 35–47.

GOODSON, I. (1987). *School subjects and curriculum change.* London: The Falmer Press.

GRUSSENDORF, S., RASALANAVHO, M., STOTT. A., TSCHEUSCNER, M., & VOLLER, N. (2005). *Shuters Physical Sciences Grade 10 Learner's Book.* Pietermaritzburg: Shuter and Shuter.

JEGEDE, O. J. (1997). Science and the development of scientific culture: A review of contemporary Science education in Africa. *International Journal of Science Education, 19*(1), 1–20.

KRATHWOHL, D. R. (2002). A revision of Bloom's Taxonomy: An overview. *Theory into Practice, 41*(4), 212–218.

MCKINNEY, C. (2005). *Textbooks for diverse learners – A critical analysis of learning materials used in South African schools* (www.hsrcpress.ac.za).

NINNES, P. (2000). Representations of indigenous knowledge in secondary school science textbooks in Australia and Canada. *International Journal of Science Education, 22*(6), 603–617.

SLEETER, C. E., & GRANT, C. A. (1991). Race, class, gender and disability in current textbooks. In M. W. Apple and L. K. Christian-Smith. (Eds), *Politics of the Textbook (pp .xx—YY).* New York: Routledge.